CLAIMS

What is claimed is:

1. A method for obtaining torques to be applied to joints of a leg of a biped walking system, comprising the steps of:

determining which leg or legs are in contact with the ground;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground;

obtaining a point of application of the ground reaction force;

obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and

obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg.

2. A method according to claim 1, wherein in a single-support mode the vertical component of the ground reaction force acting on the leg is assumed to be $M \cdot g$ and in a double-support mode the vertical component of the ground reaction force acting on each of the legs is assumed to be $(1/2) \cdot M \cdot g$, where M is a weight of a person and g is the acceleration of gravity.

3. A method according to claim 1 or 2, wherein in the step of determining which leg or legs are in contact with the ground, the determination is made based on a value of the vertical component of acceleration measured on the body.

Col. 5, lines 1-29

4. A method according to claim 1 or 2, in the step of determining which leg or legs are in contact with the ground, the determination is made using a sensor.

5. A method according to any one of claims 1 to 4, wherein in the step of obtaining a point of application of the ground reaction force, the point is obtained based on the attitude of the leg and a location of the center of gravity of the body.

6. A method according to claim 5, wherein in the step of obtaining a point of application of the ground reaction force, the point is obtained further using information from a sensor.

7. A method according to any one of claims 1 to 6, in the step of obtaining moments acting around the joints of the leg, at first the vertical component of a force acting on and a moment acting around the knee joint of the shin, are obtained using the vertical component of the ground reaction force acting on the shin at the point of application of the ground reaction force and a term of the acceleration of gravity and without using the horizontal component of the ground reaction force and a term of acceleration except the term of the acceleration of gravity and then the vertical component of a force acting on and a moment acting around the hip joint of the thigh, are obtained using the vertical component of a force acting on and a moment acting around the knee joint of the thigh and a term of the acceleration of gravity and without using the horizontal component of the horizontal component of the force acting on the knee joint and a term of acceleration except the term of the acceleration of gravity.

8. A method for obtaining moments acting around joints of a leg of a biped walking system, comprising the steps of:

determining which leg or legs are in contact with the ground;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground;

obtaining a point of application of the ground reaction force; and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity.

9. A processor for obtaining torques to be applied to joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints and at least one sensor set on the body of the biped walking system, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one sensor set on the body;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including the leg;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body;

obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and

without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and

obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg. Col 4, lines 24 – 38

10. A processor for obtaining torques to be applied to joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints, at least one sensor set on the body of the biped walking system and at least one sensor set on the leg, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one sensor set on the leg; Col 4, lines 30-37

obtaining an attitude of the leg, using information from the angular sensors; fig 3

obtaining a location of the center of gravity of the whole body including the leg; 103

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one sensor set on the body; 103

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground, the attitude of the leg, the location of the center of gravity of the whole body and the vertical component of acceleration of the center of gravity of the whole body;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body; Col 5, lines 1-29 & 103

obtaining moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and

without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity; and

obtaining the torques to be applied to the joints of the leg, based on the moments acting around the joints of the leg.

11. A processor for obtaining moments acting around joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints, at least one sensor set on the body of the biped walking system, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one sensor set on the body;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including the leg;

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one sensor set on the body;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body; and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of

gravity.

12. A processor for obtaining moments acting around joints of a leg of a biped walking system, the processor being operable in association with angular sensors on the joints, at least one sensor set on the body of the biped walking system and at least one sensor set on the leg, wherein the processor is configured to perform the steps of:

determining which leg or legs are in contact with the ground, using information from the at least one sensor set on the leg;

obtaining an attitude of the leg, using information from the angular sensors;

obtaining a location of the center of gravity of the whole body including the leg;

obtaining the vertical component of acceleration of the center of gravity of the whole body including the leg, using information from the at least one accelerometer;

obtaining the vertical component of a ground reaction force acting on the leg, based on which leg or legs are in contact with the ground;

obtaining a point of application of the ground reaction force, using the attitude of the leg and the location of the center of gravity of the whole body; and

obtaining the moments acting around the joints of the leg, using the vertical component of the ground reaction force acting on the leg at the point of application of the ground reaction force, the vertical components of forces acting on the joints of the leg and a term of the acceleration of gravity and without using the horizontal components of the forces acting on the joints of the leg and a term of acceleration except the term of the acceleration of gravity.